GRADE 12 DIPLOMA EXAMINATION

Physics 30

January 1987

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
PHYSICS 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Three written-response questions for a total of 14 marks.

A physics data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. **USE AN HB PENCIL ONLY.**

Example

This examination is for the subject area of

A. Chemistry
B. Biology
C. Physics
D. Mathematics

Answer Sheet

A	B	C	D
①	②	●	④

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JANUARY 1987

PART A

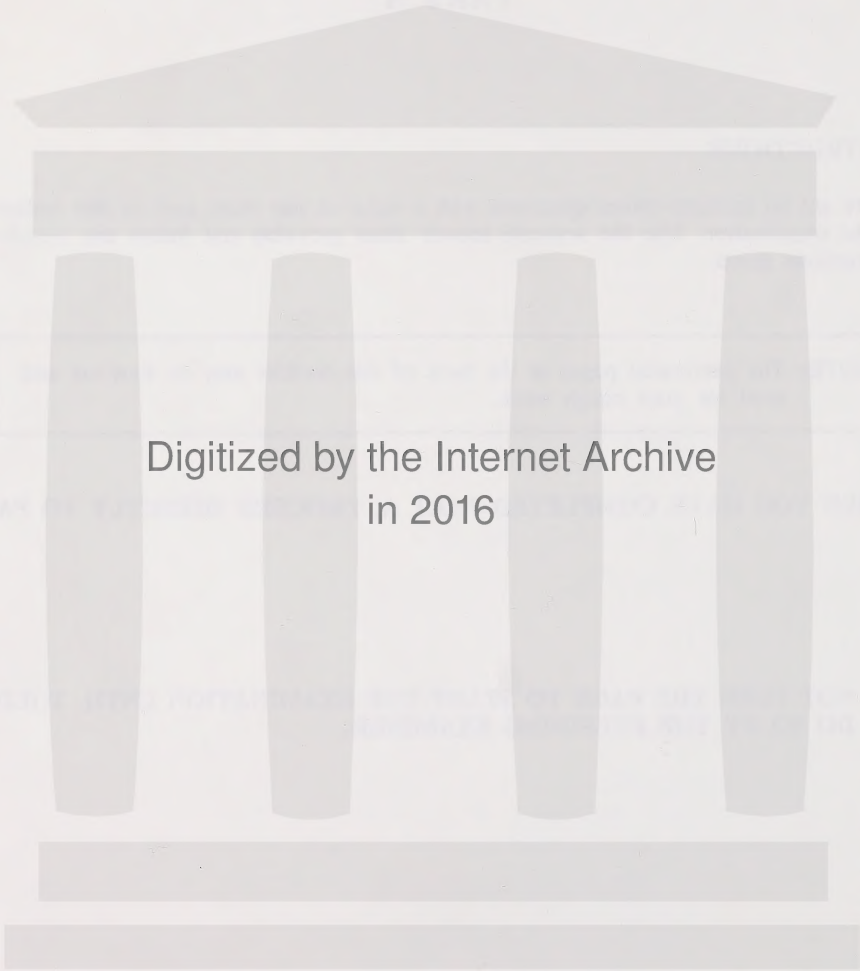
INSTRUCTIONS

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B.

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

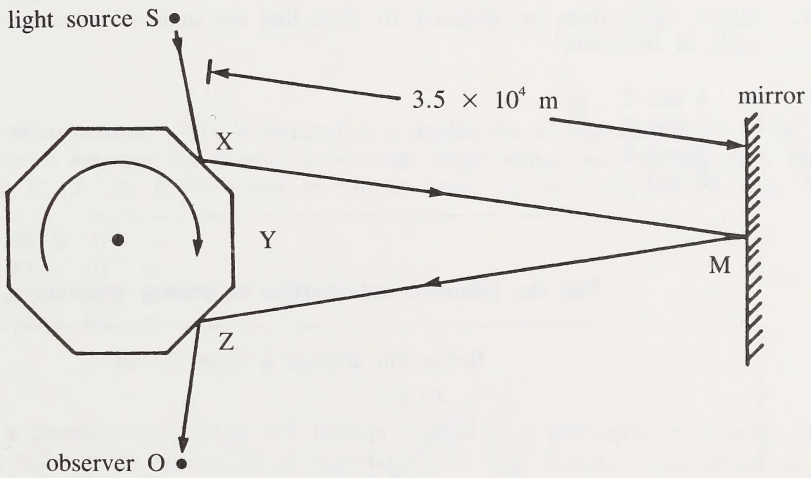


1. Römer gathered data to measure the speed of light by observing

   A. light radiated by the sun
   B. the movement of Jupiter's moons
   C. light reflected from an octagonal mirror
   D. wavelength and frequency of a light wave

Use the following information to answer question 2.

Measuring the Speed of Light



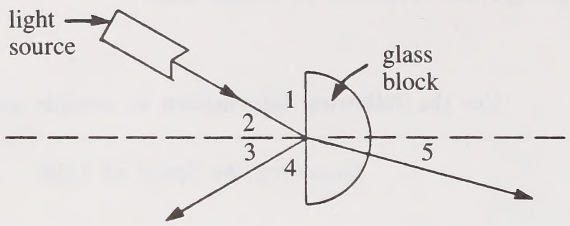
When the eight-sided mirror is stationary, light travels from S to X to M to Z to O. The distance XM is 3.5×10^4 m. When the eight-sided mirror is rotating, provided that the speed of rotation is correctly adjusted, light travels from S to X to M to Y to O (since Y will have moved to Z).

2. The eight-sided mirror rotates at 480 rev/s. The speed of light calculated from this information is

   A. 3.0×10^8 m/s
   B. 2.7×10^8 m/s
   C. 1.7×10^7 m/s
   D. 4.2×10^6 m/s

Use the following information to answer question 3.

Light Striking a Glass Block

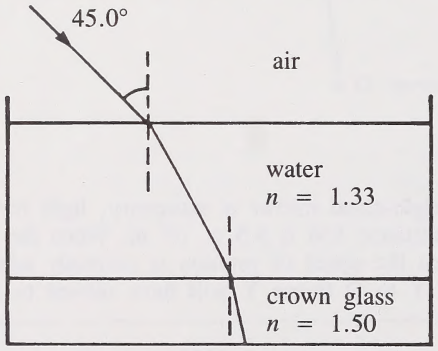


3. Which angles must be measured to show that the angle of incidence equals the angle of reflection?

A. 1 and 2
B. 1 and 5
C. 2 and 3
D. 2 and 5

Use the following information to answer question 4.

Refraction through a Water Layer



4. The angle of refraction in the crown glass is

A. 36.8°
B. 32.1°
C. 28.1°
D. 20.7°

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5. The speed of light in a transparent material is three-fifths the speed of light in air. The index of refraction of the material is

A. 0.60
B. 1.7
C. 1.8
D. 2.5

6. A light ray enters a medium that has an index of refraction of 1.50. The ratio of the wavelength in the second medium to the wavelength in air is

A. 0.333
B. 0.500
C. 0.667
D. 1.50

7. When monochromatic light is directed at a double-slit of separation 1.15×10^{-4} m, the distance between the centres of the fifth bright fringe and the fifth dark fringe is 1.27×10^{-2} m. If the screen is 6.00 m away, the wavelength of the light is

A. 1.08×10^{-7} m
B. 2.43×10^{-7} m
C. 4.87×10^{-7} m
D. 9.74×10^{-7} m

8. When a grating with 3.00×10^{5} lines/m is used in a diffraction experiment, the second-order image appears at an angle of 14.8°. The distance from grating to screen is 3.00 m. The wavelength of the light used is

A. 1.70×10^{-6} m
B. 1.32×10^{-6} m
C. 8.51×10^{-7} m
D. 4.26×10^{-7} m

9. The diffraction of light is not easily noticeable in everyday life because light

A. has such a small wavelength
B. travels at such high speed
C. travels through a vacuum
D. can be polarized

10. The correct order of colors from higher to lower frequencies is

A. green, yellow, orange
B. blue, orange, violet
C. yellow, blue, red
D. violet, red, blue

11. The three primary colors of the additive theory of light are red, blue, and green. According to this theory, a dandelion in bloom appears yellow in sunlight because it

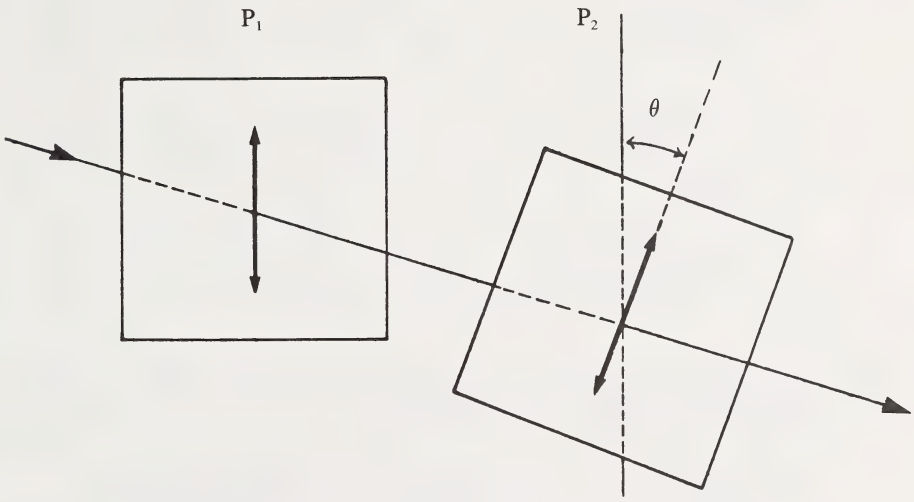
A. absorbs blue and green light, and reflects red light
B. absorbs green light, and reflects red and blue light
C. reflects blue and green light, and absorbs red light
D. reflects red and green light, and absorbs blue light

12. If a wave were transverse instead of longitudinal, the ADDITIONAL property that could be observed is

A. polarization
B. diffraction
C. dispersion
D. refraction

Use the following information to answer question 13.

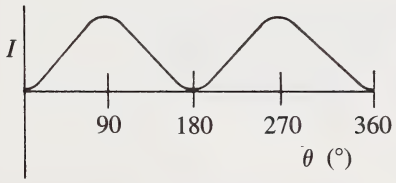
Transmission of Light through Two Polarizing Filters



A beam of unpolarized light passes in turn through a pair of polarizing filters, P_1 and P_2. P_1 is fixed in position, while P_2 is allowed to rotate through 360° from the position where $\theta = 0°$.

13. The graph which best shows how the intensity (I) of the beam of light emerging from P_2 varies with the angle θ is

A.



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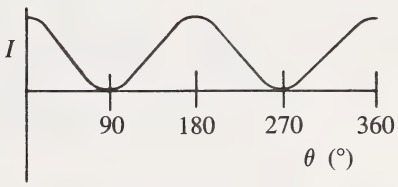
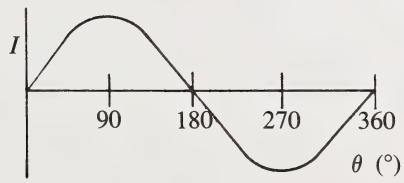
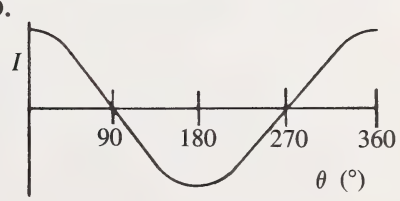


C.



D.



14. Both light and sound have all of the following properties in air EXCEPT

A. scattering
B. diffraction
C. interference
D. polarization

15. The dark portions of an interference pattern are produced by light rays meeting

A. in phase
B. out of phase
C. crest to crest
D. one wavelength apart

16. The concept of the ether as a medium for transmitting light was finally abandoned by scientists because it was shown that

A. the index of refraction of the ether appeared to be 1.00
B. an ether was not needed to transmit electromagnetic radiation
C. the chemical properties of the ether were inconsistent with its physical properties
D. the physical characteristics of the ether could not be determined before space travel

17. A solid neutral object is attracted to a positively-charged object. The two objects do not touch. The attraction is due to

A. negative charges being repelled within the neutral object
B. charge distribution being altered within the neutral object
C. positive charges changing position within the neutral object
D. there being a net gain or loss of charge within the neutral object

18. A charge of 1.0×10^{-6} C repels a charge of 2.0×10^{-6} C with a force of 20.0 N. The distance that separates the two charges is

A. 1.1×10^{3} m
B. 3.3×10^{1} m
C. 3.0×10^{-2} m
D. 9.0×10^{-4} m

19. The radius of Jupiter is 11.3 times that of Earth and its mass is 318 times that of Earth. If a person weighs 6.00×10^2 N on Earth, then on Jupiter that person will be expected to weigh

A. 2.41×10^2 N
B. 1.49×10^3 N
C. 1.69×10^4 N
D. 2.45×10^7 N

20. Millikan's oil-drop experiment demonstrates that

A. electric charges smaller than 1.6×10^{-19} C exist
B. no electric charge larger than 1.6×10^{-19} C exists
C. electric charge always comes in multiples of 1.6×10^{-19} C
D. the electric charge of an electron is an undefined multiple of 1.6×10^{-19} C

21. The magnitude of an electric field at a position 0.50 m from a point charge of 3.0×10^{-7} C is

A. 1.1×10^7 N/C
B. 1.1×10^4 N/C
C. 5.4×10^3 N/C
D. 3.2×10^{-3} N/C

22. A charged plastic sphere is midway between two parallel plates that are connected to a battery. The action that will NOT double the force on the sphere is

A. halving the distance between the plates
B. doubling the voltage of the battery
C. doubling the charge on the sphere
D. halving the area of the plates

23. Electric current is a measure of the

A. rate at which charge passes a point
B. force that moves a charge past a point
C. energy required to move a charge past a point
D. resistance to the movement of a charge past a point

24. The potential difference through which an electron must be accelerated to increase its speed from rest to 1.9×10^7 m/s is

A. 5.4×10^{-5} V
B. 1.1×10^{-4} V
C. 1.0×10^{3} V
D. 2.1×10^{3} V

25. If the direction of the electron flow through the coils of an electromagnet is reversed, the electromagnet will

A. not be affected
B. decrease in strength
C. have its polarity reversed
D. lose its magnetic properties

26. Oersted was the first to discover that a

A. current-carrying wire produces a magnetic field
B. compass needle can be deflected by a magnetic field
C. magnet moving through a coil of wire induces a current
D. charged object moving across a magnetic field is deflected

Use the following information to answer question 27.

A student makes measurements of a magnetic field surrounding a wire. The data are presented in the table below.

Magnetic Field B (10^{-9} T) for Various Currents and Distances

Current (I) \ Distance (R)	1 m	2 m	3 m
1 A	200	100	67
2 A	400	200	130
3 A	600	300	200

27. On the basis of the data, the relationship connecting B, I, and R is

A. $B \alpha I/R$

B. $B \alpha I/R^2$

C. $B \alpha IR$

D. $B \alpha I^2R$

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28. A 9.0 V potential difference exists between two metal plates which are 1.8×10^{-3} m apart. The acceleration of an electron that enters the region between these plates will be

A. 8.0×10^{16} m/s^2
B. 8.8×10^{14} m/s^2
C. 1.6×10^{7} m/s^2
D. 5.0×10^{3} m/s^2

Use the following information to answer question 29.

> In measuring the mass of an electron by deflecting electrons in a magnetic field, a student varies the voltage used to accelerate the electrons. The measurements made include orbit radius and accelerating voltage. The charge of the electron was known from a previous experiment.

29. Calculating the mass of the electron in this experiment requires that

A. the speed of the electron be measured
B. the strength of the magnetic field be varied
C. the strength of the magnetic field be known
D. only one electron at a time be in the electric field

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30. A 5.0×10^{-6} C charge moves perpendicularly across a magnetic field with a strength of 2.5 T. If the charge experiences a force of 10.0 N, what is the speed of the moving charge?

A. 1.3×10^{-4} m/s
B. 5.0×10^{4} m/s
C. 2.0×10^{5} m/s
D. 8.0×10^{5} m/s

31. An electric field will always generate a magnetic field if the electric field is

A. changing with time
B. uniform in all directions
C. produced by a point charge
D. itself created by a magnetic field

32. Scientists based their initial conclusion that light is an electromagnetic wave on the observation that

A. electromagnetic waves, like light, can be polarized
B. electric and magnetic fields that oscillate at high frequencies cause gases to emit light
C. the calculated speed of electromagnetic waves is nearly equal to the measured speed of light
D. the measured wavelength of an electromagnetic wave agrees with the wavelength calculated from the formula $\lambda = c/f$

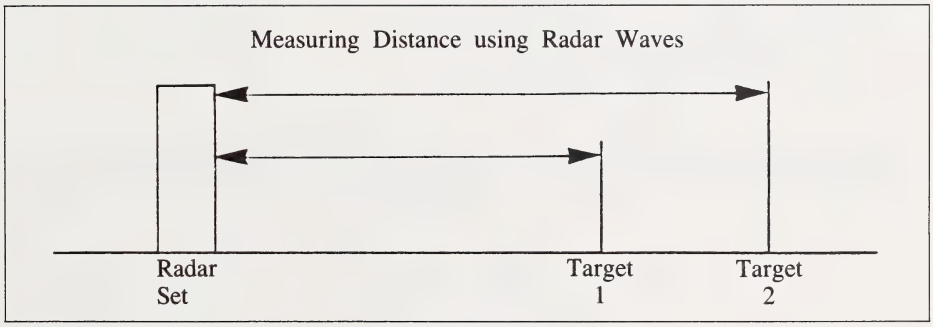
33. Which waves do NOT travel at the same speed as the others?

A. Ultrasonic
B. Infra-red
C. Radio
D. Light

34. A proton is set in oscillation. If the time for one oscillation is 1.3×10^{-17} s, what is the wavelength of the emitted radiation?

A. 2.6×10^{8} m
B. 4.3×10^{-9} m
C. 3.9×10^{-9} m
D. 7.5×10^{-16} m

Use the following information to answer question 35.



35. Two targets are at distances of 1.00×10^{3} m and 1.60×10^{3} m east of a radar set. A single pulse is transmitted by the radar set and is reflected from both targets. What is the difference between the times when the two reflected pulses are detected back at the radar set?

A. 2.0×10^{-6} s
B. 4.0×10^{-6} s
C. 6.7×10^{-6} s
D. 1.1×10^{-5} s

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36. A high-energy cathode ray is stopped by a tungsten target. This is the fundamental process involved in the production of

A. beta radiation
B. radar radiation
C. X-ray radiation
D. visible radiation

37. Copper has a valence of 2+ and an atomic mass of 63.5. The mass of copper deposited at an electrode by a 3.00 A current running for 12.0 min would be

A. 0.0120 g
B. 0.711 g
C. 1.20 g
D. 1.42 g

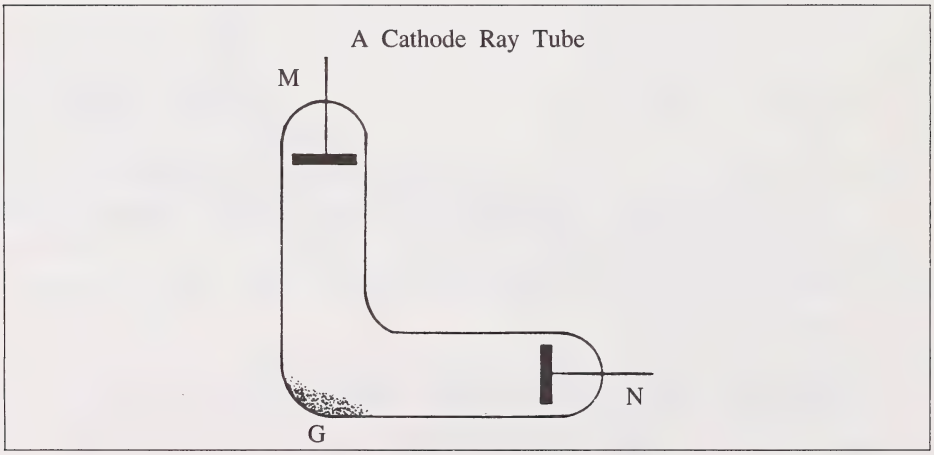
38. The proportion by mass of nitrogen to hydrogen in NH_3 is

A. 14.0 to 1
B. 4.62 to 1
C. 1 to 4.62
D. 1 to 14.0

39. J. J. Thomson found that cathode rays are deflected by

A. electric but not magnetic fields
B. magnetic but not electric fields
C. both electric and magnetic fields
D. neither electric nor magnetic fields

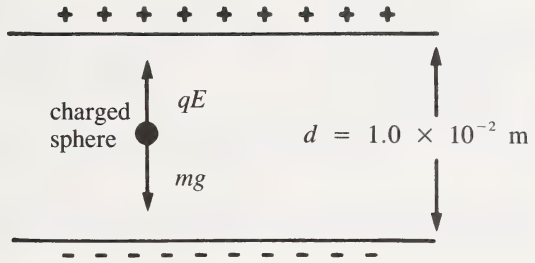
Use the following information to answer question 40.



40. In the diagram of the cathode ray tube, a green glow is observed in region G. This indicates that electrode

A. M is negative
B. N is negative
C. M is the anode
D. N is the cathode

Use the following information to answer question 41.



In the diagram a small sphere of mass m and charge q is suspended between two charged horizontal plates. The potential difference V across the plates is 2.1×10^{3} V.

41. If $q = 2$ elementary charges, then mass m is

A. 6.7×10^{-14} kg
B. 6.9×10^{-15} kg
C. 3.4×10^{-15} kg
D. 6.9×10^{-17} kg

---

42. An electron passes without deflection through perpendicular electric and magnetic fields of 10.0 kN/C and 11 mT respectively. The speed of the electron is

A. 1.1×10^{-6} m/s
B. 2.1×10^{-5} m/s
C. 9.1×10^{5} m/s
D. 4.8×10^{6} m/s

43. An electron travels at 2.5×10^{6} m/s perpendicular to a magnetic field with a strength of 2.0×10^{-3} T. The radius of curvature of its path is

A. 1.4×10^{-3} m
B. 7.1×10^{-3} m
C. 1.4×10^{2} m
D. 7.1×10^{2} m

44. The shortest wavelength of the radiation produced by an X-ray tube that operates at a potential difference of 3.00×10^{4} V is

A. 7.24×10^{18} m
B. 2.42×10^{10} m
C. 4.14×10^{-7} m
D. 4.14×10^{-11} m

45. The wavelength of the line in the Balmer series ($n_f = 2$) that corresponds to a transition from $n_i = 6$ is

A. 2.4×10^{-6} m
B. 8.8×10^{-7} m
C. 4.1×10^{-7} m
D. 9.4×10^{-8} m

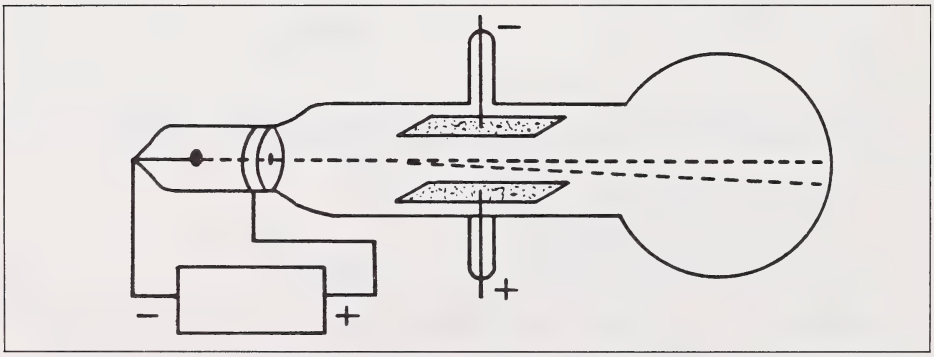
46. When light from an incandescent filament passes through a cool gas, the resulting spectrum is

A. continuous
B. red shifted
C. blue shifted
D. characterized by dark lines

47. The minimum frequency light that will cause emission of photoelectrons from a surface that has a work function of 4.5 eV is

A. 1.5×10^{21} Hz
B. 1.1×10^{15} Hz
C. 3.0×10^{14} Hz
D. 2.3×10^{14} Hz

Use the following information to answer question 48.



48. The apparatus illustrated above would be useful in determining the

A. energy levels of the hydrogen atom
B. charge-to-mass ratio of the electron
C. nature of electromagnetic radiation
D. work function of a metal

Use the following information to answer question 49.

A student performs the Millikan oil-drop experiment in which a latex sphere with a mass of 5.00×10^{-16} kg is suspended in an electric field between plates that are 9.00×10^{-3} m apart.

49. To keep the sphere suspended, the potential difference between the plates cannot be greater than

A. 3.14×10^{-3} V
B. 2.76×10^{2} V
C. 3.07×10^{4} V
D. 1.80×10^{13} V

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50. The Bohr model of the atom could NOT be used to

A. extend energy conservation principles to atomic substances
B. explain the success of Balmer's formula for hydrogen line spectra
C. expand the understanding of Planck's theory of quantization of energy
D. predict accurately the spectra of atoms with two or more electrons in the outer shell

51. Relativistic theory implies that it is impossible to travel at the speed of light because

A. of Heisenberg's uncertainty principle
B. friction with the ether becomes too great
C. the speed of light is different in different frames of reference
D. mass increases without limit as the speed of an object approaches the speed of light

52. In the Compton effect, a stream of photons, all of the same energy and momentum, strikes the scattering material. Some photons bounce off with reduced

A. wavelength
B. velocity
C. energy
D. mass

53. A Bohr-model atom has an energy of -10.0 eV in its first energy level. An electron moves from the fourth to the second level. The momentum of the photon emitted is

A. 1.00×10^{-27} kg•m/s
B. 2.00×10^{-27} kg•m/s
C. 6.60×10^{-27} kg•m/s
D. 7.50×10^{-26} kg•m/s

54. The wavelength of a proton travelling at 6.0×10^{5} m/s is

A. 6.9×10^{-21} m
B. 6.6×10^{-13} m
C. 1.2×10^{-9} m
D. 1.5×10^{12} m

55. What is a major difficulty in understanding quantum mechanics?

A. It is highly geometric.
B. It does not improve on Newtonian mechanics.
C. It is almost entirely mathematical, and difficult to visualize.
D. It states that certain materials possess neither wave nor particle properties.

56. Heisenberg's uncertainty principle states that it is NOT possible to

A. be certain about the mass of an atom
B. determine accurately the energy of a moving particle
C. be certain about the total number of subatomic particles
D. establish accurately both the position and the momentum of an electron at the same time

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

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1. Electromagnetic radiation with a wavelength of 7.05×10^{-7} m in air passes into water. The index of refraction of water is 1.33.

a. What is the wavelength of the electromagnetic radiation in water? **(1 mark)**

b. What is the period of the electromagnetic radiation in air? **(2 marks)**

c. What is the period of the electromagnetic radiation in water? **(1 mark)**

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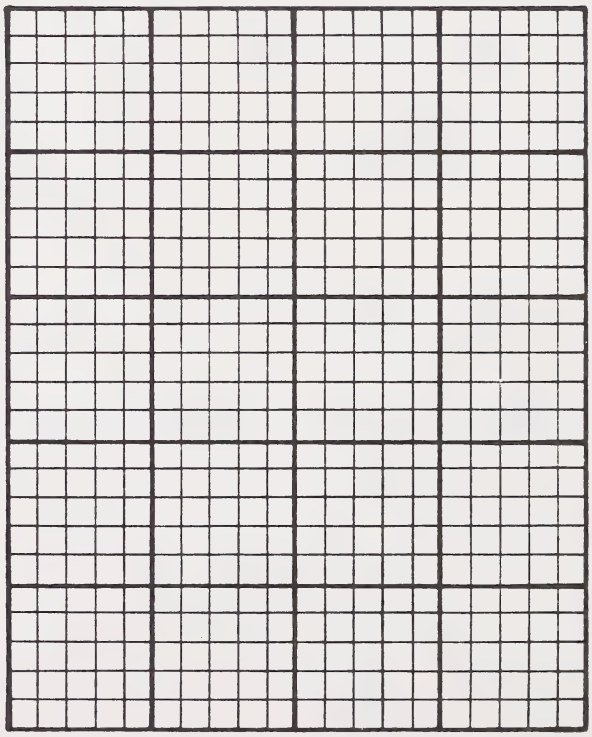
Use the following information to answer question 2.

A student using a current balance kept the currents constant, varied the length of the wire, and obtained the following data.

Length of wire (cm)	Force (number of hooks required to restore balance)
6	3
10	5
15	8
20	14
30	16
40	?

(2 marks)

2. a. Make a graph using the data above. Scale and label the axes appropriately, with the manipulated variable on the horizontal axis. Draw the best-fit line.



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b. Calculate the slope of the graph. **(2 marks)**

c. What force (number of hooks) would be required to balance a loop 40 cm long? **(1 mark)**

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3. An electron moving at a relativistic speed of 2.01×10^8 m/s enters a perpendicular magnetic field of strength 0.530 T.

(1 mark) **a.** Calculate the relativistic mass of the electron.

(2 marks) **b.** Calculate the radius of curvature of the orbit. (If you were unable to calculate an answer for part a, use the hypothetical value of 1.50×10^{-30} kg.)

(2 marks) **c.** Through what potential difference does the electron accelerate from rest in order to acquire a speed of 2.01×10^8 m/s?

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

TEAR-OUT SHEET

(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

FOLD AND TEAR ALONG PERFORATION

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M1 M2 M3 M4

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